

Evaluation of Healing Potential of Sticky Bone and Guided Tissue Regeneration Membrane in the Management of Apicomarginal Defect with Periapical Lesion Using Cone Beam Computed Tomography: A Report of Two Cases

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Abstract

Endodontic surgery aims to remove periapical pathology and regenerate periapical tissues while restoring mucogingival anatomy. An apicomarginal defect, characterized by the loss of buccal alveolus from the crestal bone to the tooth apex, poses a challenge for regeneration due to faster fibroblastic tissue proliferation than bone cells within the defect. Hence, placing barrier membranes over a biocompatible graft material is a common practice. This study reports two cases of persistent symptomatic apical periodontitis, apicomarginal defects, and large periapical lesions managed with endodontic surgery, sticky bone grafts, and guided tissue regeneration (GTR) barrier placements with a 12-month follow-up. Healing potential was evaluated using cone-beam computed tomography (CBCT). Clinically and radiographically examined at 6- and 12-month post-operative, patients were asymptomatic, and follow-up CBCT showed a marked reduction in bone defect area and significant bone density gain. The results indicate that using sticky bone grafts with GTR barrier membranes provides satisfactory bony healing in apicomarginal defects with periapical lesions post-endodontic surgery.

Keywords: Apicomarginal defect, Autologous fibrin glue, Endodontic surgery, Guided tissue regeneration, Sticky bone.

INTRODUCTION

Apicomarginal defect can be defined as a localized bony defect that is characterized by the absence of buccal alveolar bone over the total root length. These defects are periradicular lesions associated with periodontal breakdown and have a reported incidence of 3.56–20%.^[1,2] Periradicular surgery is a traditional treatment option in endodontics for the management of unhealed periapical pathologies. The amount and location of alveolar bone close to the root structures affect the prognosis of periradicular surgery. In general, the prognosis of periradicular surgery ranges from 25% to 90%.^[3] However, when the bony destruction of the pathological process includes a localized loss of marginal bone, the prognosis of periapical surgery is found to be 27% and 37%.^[4,5] The reason for limited success has been recognized as the formation of long junctional epithelium over the dehiscence root surface. Apicomarginal defects are infrequent, they represent a significant challenge to healing.^[6,7]

Guided tissue regeneration (GTR) therapy introduced in the 1980s has been widely used to regenerate lost periodontium from periodontal disease. It has also been introduced in endodontic surgeries as a concomitant treatment during the management of endodontic-periodontal lesions.^[8,9] The use of GTR membranes has shown a significantly higher success rate in apicomarginal defects. The placement of a physical barrier over an osseous defect can prevent the ingrowth of faster proliferating oral epithelium and gingival connective tissue from growing into the bony defect, permitting the cells

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Received: 25.07.2024; **Accepted:** 05.08.2024; **Published:** 10.08.2024

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How to cite this article: Das D, Mondal P, Saha KK, Mistry K, Das S, Saha D. Evaluation of Healing Potential of Sticky Bone and Guided Tissue Regeneration Membrane in the Management of Apicomarginal Defect with Periapical Lesion Using Cone Beam Computed Tomography: A Report of Two Cases. *J Res Adv Dent* 2024;15(5):1-7.

Access this article online

Website:
www.jrad.co.in

DOI:
<https://doi.org/10.53064/jrad.2024.15.5.563>

from the periodontal ligament and endosteum to colonize the blood clot and regenerate the lost tissue.^[11-14]

A newly developed product of fabricating growth factors-enriched bone graft matrix (also known as “sticky bone”) using autologous fibrin glue (AFG) has been introduced in 2010 by Sohn DS *et al.*^[15] It contains the mineral scaffold for bone cells necessary for bone formation. It also contains various growth factors such as platelet-derived growth factors, transforming growth factors (TGF)- β 1 and β 2, fibroblast growth factors, vascular endothelial growth factors, and insulin-like growth factors, which stimulates cell proliferation, matrix modeling, and angiogenesis. Sticky bone contains a much larger, denser, richer fibrin matrix enriched with growth factors than platelet-rich fibrin and has both osteoinductive and osteoconductive character.^[16,17]

The present two case reports describe cone-beam computed tomography (CBCT) evaluation of the healing of apicomarginal defect with large periapical pathology associated with maxillary incisor teeth through a combination use of sticky bone and GTR membrane after periapical surgery.

CASE REPORT

Case no. 1

A 22-year-old systemically healthy, non-smoker male patient reported to the Department of Conservative Dentistry and Endodontics of the Dental College and Hospital with a chief complaint of pain and pus discharge concerning the upper left anterior teeth region for the last 6 months. He gave a history of trauma in the maxillary anterior region 7–8 years ago.

On clinical examination, extra orally, no abnormality was detected. Intra orally, discolored teeth #21 and #22 were found (Figure 1a). Both the affected teeth were tender on percussion. Periodontal pocket depth ranged from 9 to 10 mm (Figure 1b) and Grade I tooth mobility was seen concerning #22. There was no gingival recession with #21 and #22.

An intraoral periapical radiograph (IOPAR) of the affected teeth showed a well-defined large periradicular radiolucency concerning teeth #21 and #22. (Figure 1c) CBCT evaluation of #21 and #22 revealed the presence of localized periapical bone loss with loss of facial cortical plate and marginal alveolar bone

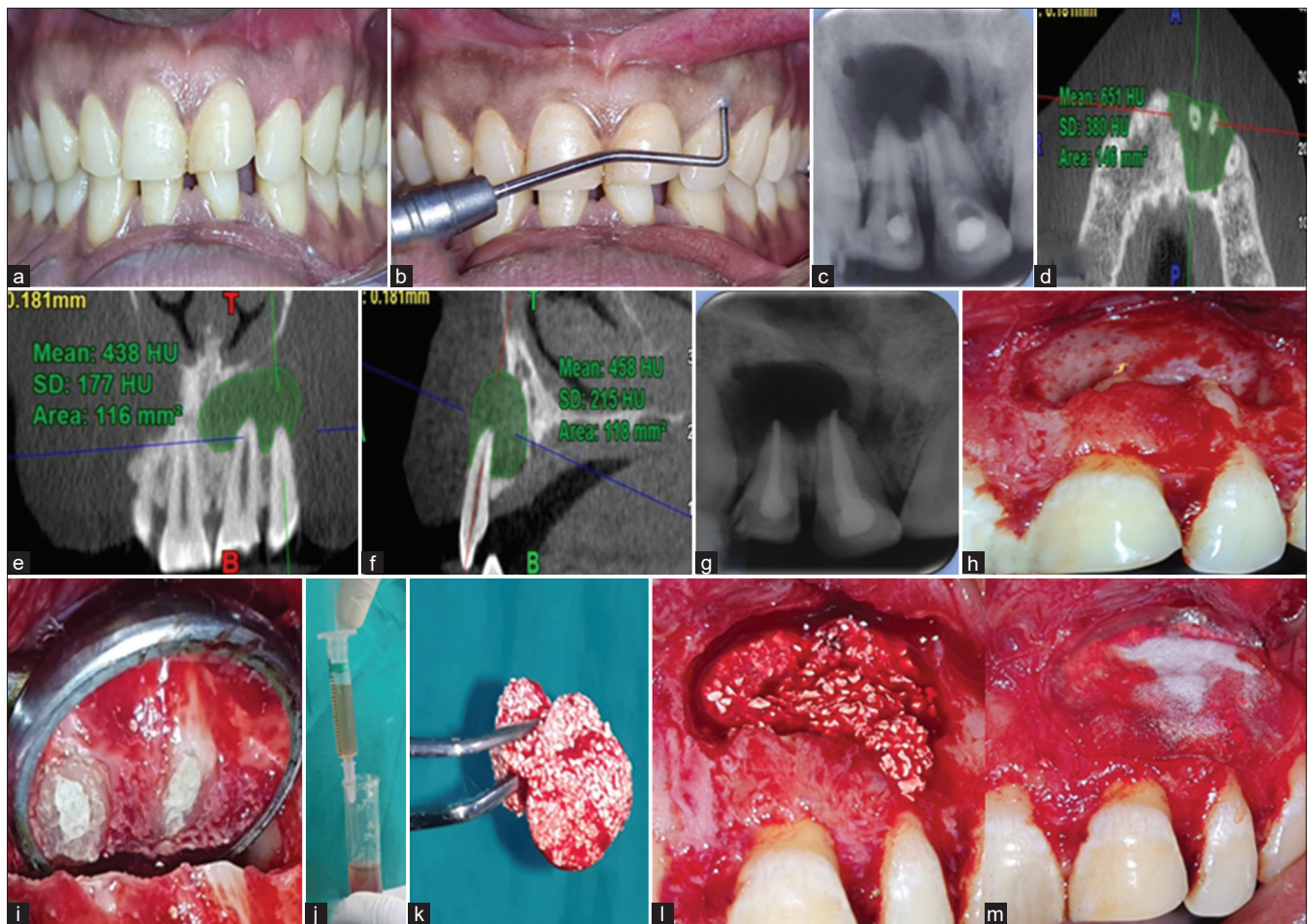


Figure 1: Procedural images for Case 1: (a) pre-operative clinical view showing discolored front tooth, (b) periodontal pocket depth measured, (c) pre-operative intraoral periapical radiograph, (d) pre-operative cone-beam computed tomography scan in axial section, (e) pre-operative cone beam computed tomography scan in coronal section, (f) pre-operative cone beam computed tomography scan in sagittal section, (g) post-obturation radiograph, (h) periapical and apicomarginal bone defect after cyst enucleation (i) apicoectomies and retro filled roots, (j) Autologous Fibrin Glue prepared and collected in a syringe, (k) sticky bone prepared (l) sticky bone graft placed in the osseous defect, and (m) guided tissue regeneration membrane placed

along the labial aspect of #21 and #22 (Figure 1d-f) indicating a diagnosis of apicomarginal defect and a concurrent endodontic and periodontal disease in #21 and #22.

The complete treatment procedure was explained to the patient and an informed consent was taken. Under local anesthesia (2% lignocaine and 1: 80000 adrenaline) and rubber dam isolation, endodontic treatment was initiated on #21 and #22. The canals were cleaned and using 3% sodium hypochlorite (Prime Dental Products Pvt. Ltd.) as irrigant. The canals were dried with paper points and calcium hydroxide (CH) paste (Ultralcal XS, Ultradent Products, South Jordan) was placed as an intracanal medicament and the access cavities of both teeth were temporized with zinc-oxide eugenol restoration (Cavition, GC Corporation, Japan) and the patient was advised to maintain proper oral hygiene. After 4 weeks it was found that the pocket concerning #21 and #22 was persistent but the patient was asymptomatic. Intracanal medication was replaced with new CH medication in #21 and #22 and the patient was again recalled after 3 months for further evaluation, which revealed a persistent localized pocket of 10 mm about #21 and #22. Furthermore, there was no reduction in the size of periapical radiolucency concerning #21 and #22 found on radiographs. Hence, surgical intervention was planned. One week before surgery, teeth #21 and #22 were obturated with gutta percha using the cold lateral compaction technique using AH plus sealer (Dentsply Maillefer, USA). The access cavities were sealed with glass ionomer cement (Fuji II, GC Co., Tokyo, Japan) (Figure 1g).

Before surgical intervention, complete blood investigations including serological tests were done.

During surgery, under local anesthesia using 2% lidocaine with 1: 80,000 epinephrine (Xylocaine; Astra Zeneca Pharma, Bengaluru, India) a full-thickness mucoperiosteal flap was elevated and apicomarginal defect with #21 and #22 were found. The bony window preparation was done, the cystic lining was enucleated (Figure 1h) and the tissue was sent for histopathological examination. Thorough scaling of the root surfaces of both teeth was done with ultrasonic instruments. Then apical 3 mm of the roots of both #21 and #22 were resected and retrocavity preparation was done using an E10D ultrasonic tip (Guilin Woodpecker, China). The root end cavities of the teeth were filled with mineral trioxide aggregate (MTA) (MTA Angelus, Brazil) (Figure 1i) and were verified by IOPAR. Sticky bone was prepared by collection of 10 mL blood from the antecubital vein of the patient in a 10 mL test tube. Blood was centrifuged immediately without an anticoagulant in a centrifugation machine (Remi R8-C) at 2700 RPM for 2 min. After centrifugation, the resultant product comprised AFG at the top of the tube and red blood corpuscles at the bottom. The AFG was collected in a syringe (Figure 1j) and mixed with hydroxyapatite crystals (SYBOGRAF-Plus, Eucare pharmaceuticals Ltd., Chennai) and allowed for 5–10 min for polymerization to produce sticky bone (Figure 1k). After preparation, sticky bone graft was placed in the apicomarginal

and periapical bony defect (Figure 1l). The grafted area was covered with a resorbable collagen membrane (Periocol-GTR, Eucare Pharmaceuticals, Chennai, India), keeping in mind to cover the margins with at least 2 mm (Figure 1m). The flap was repositioned and sutured with 3-0 black silk sutures (Unisil, Unisure Lifecare Pvt. Ltd, Bengaluru, India), and a post-operative IOPAR was taken. The patient was instructed regarding post-operative care and sutures were removed after 8 days of surgical treatment.

The patient was revisited at 6 and 12 months for clinical and radiographic evaluation (Figure 2). At 12-month follow-up, the patient was asymptomatic, and clinical examination showed that teeth were functioning normally and were not tender on percussion or palpation. The soft-tissue healing was satisfactory and probing depth was within normal limits. IOPAR revealed evidence of a significant amount of bone deposition. CBCT examination showed that there were a gradual increase in bone density (Hounsfield Units [HU]) and a decrease in radiolucent area. It was observed that the percent increase in bone density was 119.9%, and 140.6% at 6 and 12 months, respectively, and at the same time interval, the decrease in the radiolucent area was found to be 95.3%, and 95.8%, respectively (Table 1).

Case no. 2

A 29-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in the upper left anterior teeth region for the past 3 months. He gave a history of trauma in the maxillary anterior region 7 years ago. Clinical examination revealed Grade 1 tooth mobility and a periodontal pocket depth ranging from 8 to 9 mm with #21. IOPAR and CBCT scan revealed the presence of localized periapical bone loss in relation to #21 and #22 with loss of buccal cortical plate and marginal bone along the labial aspect of #21. EPT confirmed that the teeth were non-vital and were tender on percussion.

Endodontic treatment was started in #21 and #22. After completion of proper cleaning and shaping and repeated placement of CH paste (Ultralcal XS, Ultradent, South Jordan) as an intracanal medicament for up to 3 months, radiographically, there was no reduction in the size of periapical radiolucency seen about #21 and #22. Hence, endodontic surgery was planned for the treatment of the defect. One week before surgery, obturation was done following the same protocol as in Case 1 in #21 and #22. Surgical procedures were performed as mentioned in case 1. After root resection, the retrograde filling was done by MTA; the sticky bone was prepared by the same method used in Case 1 and placed over the bony defects, and the GTR membrane (Periocol-GTR, Eucare Pharmaceuticals, Chennai, India) was placed over the defect side (Figure 3).

The patient was reevaluated clinically and radiographically at 6- and 12-month period during which there were no symptoms of pain, discomfort, alongwith satisfactory soft-tissue healing, and normal probing depth. Follow-up CBCT scans revealed that a percent increase in bone density was 85.9 and 125.5 %, and

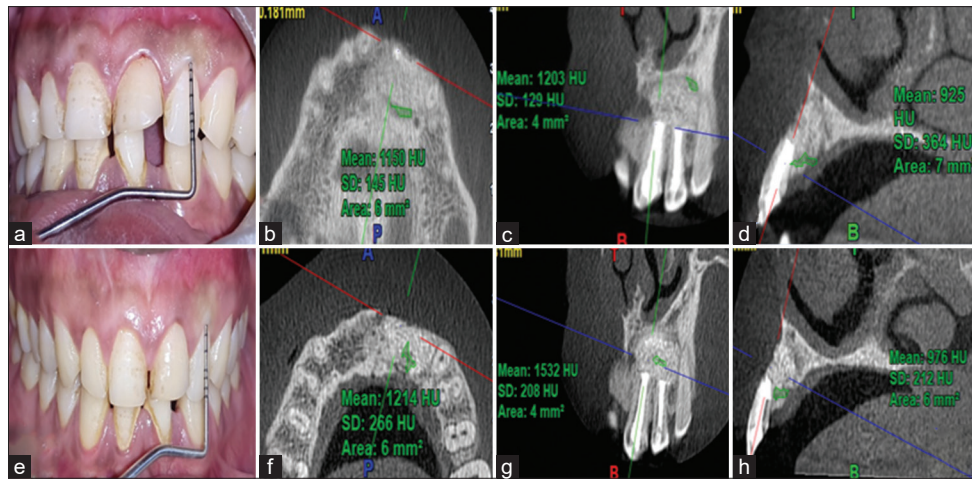


Figure 2: Post-operative probing depth and cone beam computed tomography evaluation of bone density and lesion size in Case 1 (a) probing depth at 6-months, (b) 6 months in axial section, (c) 6 months in coronal section, (d) 6 months in sagittal section, (e) probing depth at 12 months, (f) 12 months in axial section, (g) 12 months in coronal section, and (h) 12 months in sagittal section

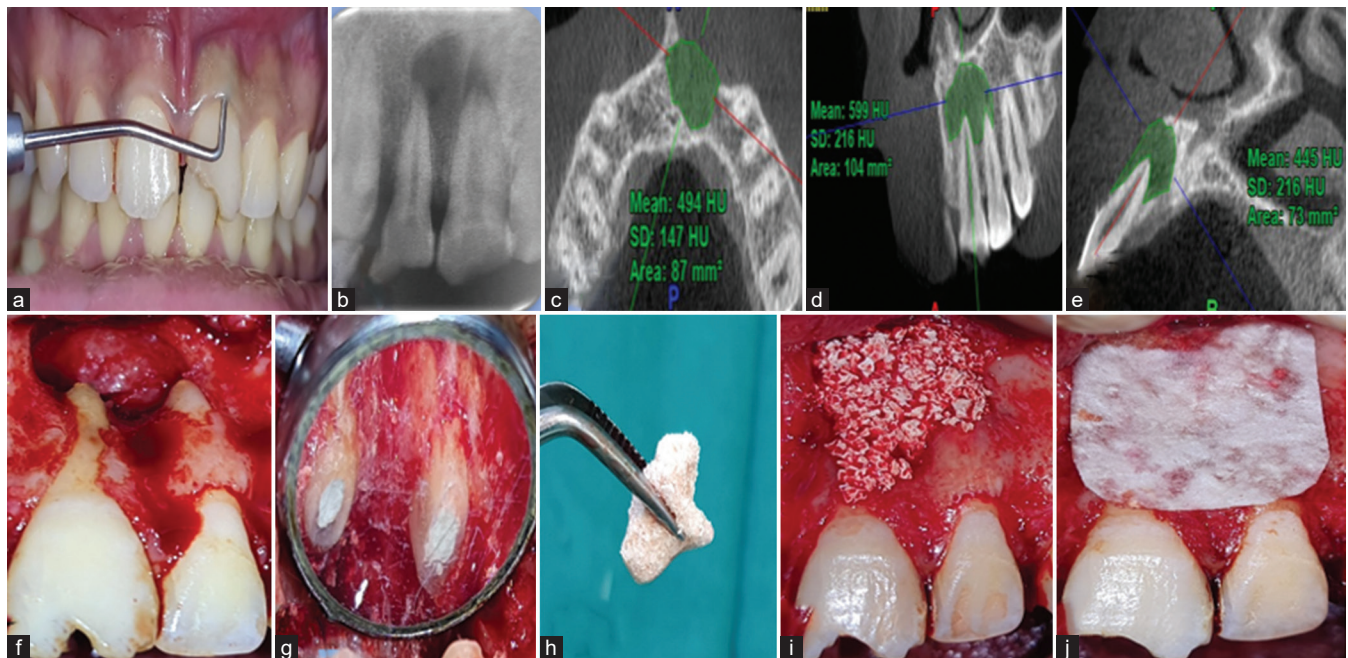


Figure 3: Summarized clinical image series for Case 2: (a) pre-operative clinical view showing fractured and discolored front tooth with significant periodontal pocket depth measured, (b) pre-operative intraoral periapical radiograph, (c) pre-operative cone beam computed tomography scan in axial section, (d) pre-operative cone beam computed tomography scan in coronal section, (e) pre-operative cone beam computed tomography scan in sagittal section, (f) periapical and apicomarginal bone defect after cyst enucleation, (g) apicoectomised and retro filled roots, (h) sticky bone prepared, (i) sticky bone graft placed in the osseous defect, and (j) guided tissue regeneration membrane placed

Table 1: CBCT evaluation values represent a gradual increase in bone density (Hounsfield Units [HU]) and a decrease in the radiolucent area (mm²) at the 6th- and 12th-month follow-up in Case 1

Time points	Parameters	Axial	Coronal	Sagittal	Average value	% gain in BD	% reduction in LS
Pre-operative	BD	651	438	458	515.6		-
	LS	146	116	118	126.6		
6 th month	BD	1150	1203	925	1092	119.9	95.3
	LS	6	4	7	5.6		
12 th months	BD	1214	1532	976	1240.6	140.6	95.8
	LS	6	4	6	5.3		

CBCT: Cone-beam computed tomography, BD: Bone density (in Hounsfield's Units); LS: Lesion Size (in mm²)

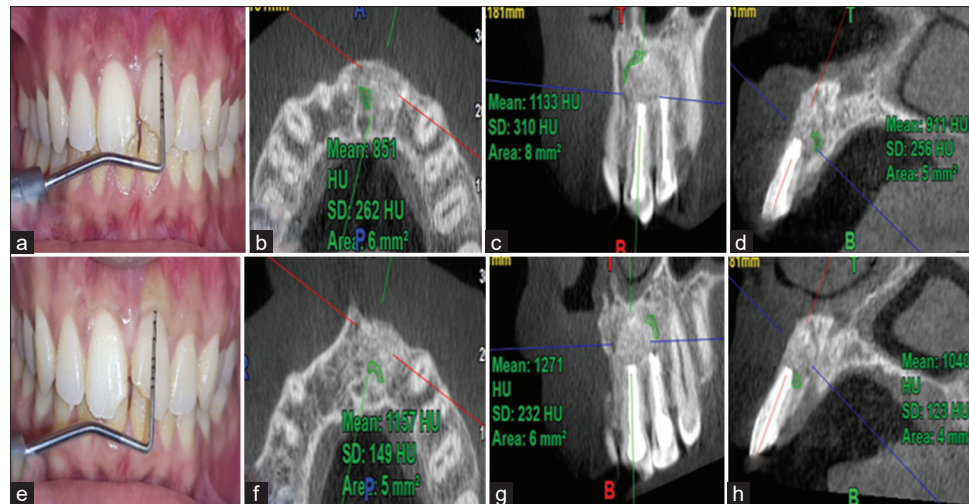


Figure 4: Post-operative probing depth and cone-beam computed tomography evaluation of bone density and lesion size in Case 2 (a) probing depth at 6 months, (b) 6 months in axial section, (c) 6 months in coronal section, (d) 6 months in sagittal section, (e) probing depth at 12 months, (f) 12 months in axial section, (g) 12 months in coronal section, and (h) 12 months in sagittal sections

Table 2: CBCT evaluation values represent a gradual increase in bone density (Hounsfields Unit [HU]) and a decrease in the radiolucent area (mm²) at the 6th- and 12th-month follow-up in Case 2

Time Points	Parameters	Axial	Coronal	Sagittal	Average value	% gain in BD	% reduction in LS
Pre-operative	BD	494	5 99	445	512.6		-
	LS	87	104	73	88		
6 th months	BD	851	1133	911	953	85.9	90.5
	LS	6	8	5	6.3		
12 th months	BD	1157	1271	1040	1156	125.5	94.3
	LS	5	6	4	5		

CBCT: Cone-beam computed tomography, BD: Bone density (in Hounsfield's Units); LS: Lesion Size (in mm²)

and at the same time interval, the decrease in the radiolucent area was 90.5% and 94.3%, respectively (Table 2 and Figure 4).

DISCUSSION

Apicomarginal defects are characterized by a localized complete loss of marginal bone and communicating with a periodontal pocket which represents a significant challenge to healing compared with the defects confined to the periapical area only. It has been suggested that the use of a physical barrier membrane over the denuded root surface prevents the formation of epithelial downgrowth. However, with a better understanding of healing mediated by biological mechanisms, the focus of attention is now shifting toward regenerative and reconstructive therapies.^[5,7,8]

Regeneration of tissue after periapical surgery requires (a) recruitment of progenitor/stem cells to differentiate into various blast cells, (b) growth/differentiation factors as necessary signals for attachment, migration, proliferation, and differentiation of cells, and (c) local microenvironmental molecules, such as adhesion molecules, extracellular matrix, and associated noncollagenous protein molecules. Lack of any of these elements would result in repair rather than regeneration.^[6,9]

The presented cases highlight the prognostically reserved Kim's class F defect characterized by endo-periodontal lesions primarily caused by endodontic factors with secondary periodontal involvement and associated marginal bone defects in various teeth. These cases were successfully managed using microsurgery combined with GTR utilizing bone grafts. In a prospective study conducted in South Korea, Kim demonstrated a success rate of 78% for cases classified as Kim's classes D, E, and F, compared to 95% for cases classified as classes A, B, and C, emphasizing the significance of the marginal bone factor.^[7] The destruction of marginal bone found in apical-marginal defects reduces the success rate of treatment to 27% and 37%.^[10-14]

Numerous biomaterials for GTR including resorbable or non-resorbable membranes, periosteal grafts, and various bone grafts have been found in the literature.^[15-19] Pecora *et al.*^[20] concluded that placing an expanded polytetrafluoroethylene membrane (without bone graft) at the entrance of a lesion larger than 10 mm in diameter, as measured on radiographs and lacking apicomarginal communication, leads to accelerated bone regeneration.^[19] Pompa^[21] reported three successful clinical cases using only non-resorbable membranes without the use of any bone graft. However, after 6 months, these membranes needed to be removed, requiring a second surgical

intervention. To avoid the need for another surgical approach, resorbable membranes have been utilized, which have shown similar clinical and histological behavior to non-resorbable membranes. In the presence of apicomarginal defects, these resorbable membranes, in combination with a xenograft achieved a success rate of 83% after 1 year.^[22,23] Collagen has been found to promote platelet aggregation and fibroblast migration, thereby assisting in clot stability and surgical wound healing.^[21] Britain *et al.*^[23] demonstrated significant advantages of using these membranes, with or without the placement of a xenograft, compared to not employing GTR in cases of apicomarginal defects of primary endodontic origin.

Therefore, the placement of a barrier membrane in surgical endodontics aims to create an optimal environment for tissue regeneration, similar to its application in periodontology and implantology. This involves the establishment of a stable and protected blood clot, exclusion of fast proliferating undesirable cells from the healing process in the bone defect, and facilitation of migration of periodontal ligament, cementum, and bone cells to promote true new insertion. However, it should be noted that barrier membranes used in GTR can degrade over time or become exposed, potentially compromising the success of the procedure. Secondary infections or other complications may arise, leading to incorrect regeneration.^[22]

The “sticky bone” is a homogenous product comprising a mineral scaffold for bone cells vital for bone formation. It also contains growth factors necessary for the stimulation of differentiation or migration of cells. Sticky bone is advantageous because of its better adaptability over various shapes of the bony defect, and prevention of the micro and macro movement of grafted bone thus maintaining the volume of augmentation during the healing period, accelerating soft tissue and bone healing by releasing growth factors. Moreover, the preparation does not require any biochemical additives, such as platelet-rich plasma and plasma rich in growth factors.^[15,16]

It is worth highlighting that apicomarginal defects are often present with clinical features that resemble those of vertical root fractures. Therefore, achieving a definitive diagnosis for these cases through exploratory surgery is of paramount importance to prevent unnecessary extraction of potentially salvageable teeth. Considering that controlling the infiltration of microorganisms and their byproducts from the root canal system into the periodontium is a fundamental prerequisite for both surgical and non-surgical endodontic success.^[17,24,25]

Baruwa *et al.* reported 13 successful cases of apicomarginal defects using resorbable collagen membranes and bone grafts with a follow-up period of 9 years and concluded that endodontic microsurgery with GTR is a viable treatment option in managing teeth with large periapical lesions and apicomarginal defects.^[26]

Most of the reports published in the literature have used periapical radiographs to evaluate bony changes associated with the involved tooth except Rachana *et al.*^[27] who used

CT. Furthermore, Rajput *et al.*^[28] who had used CBCT for initial evaluation. In our case reports, both IOPAR and CBCT were used for initial evaluation and post-operative follow-up. At 12 months, radiographic assessment criteria were applied to pre- and post-operative IOPAR and CBCT, confirming complete healing. The results suggest that using sticky bone combined with a GTR membrane promotes bone healing and growth in apicomarginal and periapical bone defects.

CONCLUSION

This report highlights the effectiveness of combining sticky bone grafts with GTR membranes in the management of apicomarginal defects with periapical lesions. Both cases showed significant clinical and radiographic improvement, with marked reductions in bone defect areas and substantial gains in bone density, as evidenced by CBCT evaluations at 6 and 12 months. These findings suggest that a combined treatment approach offers a promising solution for achieving satisfactory bony healing and restoring function in complex apicomarginal defects post-endodontic surgery.

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